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COMMON PERSIMMON (*DIOSPYROS VIRGINIANA* L.), A NATURALIZED, POTENTIALLY INVASIVE SPECIES IN THE STATE OF CALIFORNIA

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ABSTRACT

Common persimmon (*Diospyros virginiana* L.) is a deciduous tree occurring widely in eastern North America, as far west as Texas. The species is known for producing relatively large, edible fruits that were consumed by Native Americans and by the European colonists who arrived in North America more recently. Because of its fruit production, *D. virginiana* is broadly planted outside its natural range. Here, I report on five naturalized occurrences of *D. virginiana* found in the state of California, where the species is not native. In 2016 and 2017, these populations were surveyed and monitored for fruit production. In all populations, mature fruits were found in the autumn, and these fruits were observed to produce viable seeds with filled embryos. Two of the populations have greater than 70 individuals and contain trees at varying levels of maturity. It is not yet known if these populations are the result of asexual reproduction via root sprouting or sexual reproduction via diaspores. However, the production of viable diaspores in all surveyed populations indicates that sexual seed set is occurring. The large size of two stands, one along a creek in Butte County and the other on a river flood plain in Tulare County, suggests that some areas of California might be susceptible to invasion by this species. Future research should try to determine whether recruitment via diaspores is occurring, and whether these seeds are the product of selfing in perfect-flowered plants, or cross fertilization in a population containing both male and female plants, as this would have important implications for the potential invasiveness of this species in the state.

Key Words: Butte County, California, Tulare County, persimmon, riparian.

Common persimmon (*Diospyros virginiana* L. var. *virginiana*, Ebenaceae) is a medium sized deciduous, dioecious tree, reproducing sexually via seeds embedded in fleshy berries and vegetatively by resprouting from roots and the buried root crown (Eckenwalder 2009). *Diospyros virginiana* is a widespread element of temperate deciduous forests in the eastern United States, with its native range spanning from Connecticut south into northern Florida, and as far west as eastern Texas (Eckenwalder 2009). The plant has long been appreciated for its edible fruits, consumed by indigenous people of what became the United States, and then by European colonists and their descendants (Briand 2005). The plant has a long history of cultivation, including by indigenous people prior to the arrival of European colonists, and is still grown for its fruits in some areas of the United States (Briand 2005). Although the species does not occur natively west of Texas (Eckenwalder 2009), it has been documented in California as a cultivated waif (Hrusa et al. 2002; Baldwin et al. 2012; Baldwin, University of California, Berkeley personal communication), and also as a naturalized part of the introduced flora (Jepson Flora Project 2017). Nevertheless, the species is not yet included as naturalized in the most authoritative reference manual of California vascular plants, the Jepson eFlora (Jepson Flora Project 2017).

As discussed by Hrusa et al. (2002), the fact that this plant has been cultivated for hundreds of years in the United States (Briand 2005) and is capable of persisting for some time as a mature tree, may compromise our ability to determine whether existing trees represent population recruitment or are simply the survivors of historical orchard plantings. As with many cultivated plants, this ambiguity is why this plant has not been widely recognized as naturalized in the state (Baldwin, University of California, Berkeley personal communication). In addition to a lack of consensus as to the ability of this plant to persist under natural conditions, nothing is known about the potential for this tree to become invasive (*sensu* Richardson et al. 2000) in the state.

In 2015, the author discovered a large, but previously unreported (Oswald and Ahart 1998), population of *D. virginiana* in the lower Butte Creek watershed, Butte County, CA (Table 1). Discovery of this extensive and seemingly expanding population (Burge personal observation) made the author wonder if this fast-growing, non-native might pose a risk as an invasive species. Inspired by the Butte County discovery, the author visited several other reported occurrences of *D. virginiana* in California. Data were collected on population size, age structure, and capacity for sexual reproduction. The overall aim of this work was to determine 1) whether this plant is naturalized in the state of California, and thus a candidate for inclusion in the Jepson Flora Project, and 2) if there is any risk that this tree might become an invasive species in the state.

METHODS

In the autumn and early winter of 2016, the author visited six known populations (i.e., occurrences) of

TABLE 1. SURVEYED SITES, WITH DEMOGRAPHIC AND SEED VIABILITY DATA. Site code corresponds to the collecting code used by the author (Appendix 1). Viable seed refers to whether the seeds collected at a site had filled embryos (based on a cut test).

			Demographics					
			Adult diameter at breast height (cm)			Sapling height (m)		
Site code	County	Viable seed present?	n	Range	Average ± SD	n	Range	Average ± SD
2184	Butte	Yes	66	2.1–37.5	8.5 ± 6.7	8	0.72–1.54	1.19 ± 0.31
2202	Tulare	Yes	76	2.2–33.4	8.5 ± 6.1	31	0.60–1.25	1.50 ± 0.39
2210	San Bernardino	Yes	9	2.2–10.5	7.2 ± 3.0	0	–	–
2211	San Bernardino	Yes	10	2.0–42.0	8.0 ± 12.1	15	0.5–2.2	1.30 ± 0.60
2215	San Diego	Yes	10	4.7–27.4	14.9 ± 6.3	0	–	–
2217	San Diego	No	1	8.3	–	0	–	–

D. virginiana, in addition to the one in Butte County discovered by the author (Table 1). These additional occurrences were selected from among the records of Ebenaceae catalogued by 1) the Consortium of California Herbaria (CCH 2017), 2) the Biota of North America Program (BONAP) (Kartesz et al. 2017), and 3) Hrusa et al. (2002). Occurrences were selected on the basis of their likelihood to represent naturalized occurrences.

Occurrences were accessed via vehicle and on foot. At each occurrence, the presence of live plants was verified, and a voucher specimen was collected. In each population, the author made a survey on foot, attempting to access every tree in the population. The author took a measurement of diameter at breast height (dbh) for all observed individuals over one cm dbh and measured the height of all other trees (seedlings and saplings). In all the populations, other than the Kaweah River site (D. Burge 2202, Table 1), every plant in the local population was measured. At the very large Kaweah River population, an area of 10,000 m^2 was surveyed (100 m × 100 m) to provide a snapshot of the demographics of the plants found in this area (Appendix 1). All dbh measurements were made using a flexible, metric measuring tape; all measurements of height were made with a metric scale construction tape measure. The author also surveyed for the presence of ripe fruits and collected whole seeds from fruits when present. Whole seeds were cleaned of flesh under running water and air dried. The viability of the seeds was assessed via cut tests, using a single-sided razor blade to bisect the seeds longitudinally (along the axis of the cotyledons). Seeds with plump endosperm and an embryo were assumed to be viable.

In addition to population census field work, visits were made to local historical museums in the Butte Creek Canyon (Centerville Recreation and Historical Society) and Three Rivers area (Three Rivers Historical Society) to obtain information on early European settlers of these regions, and thereby ascertain whether *D. virginiana* was deliberately planted by these settlers.

RESULTS

A total of six sites were visited in four counties (Table 1, Appendix 1). Live *D. virginiana* plants were found at each site, although the geographic extent of the populations, the size distribution of the plants, and their success in producing viable seeds was highly variable (Table 1). At the Lawson Creek site in San Diego County (D. Burge 2217, Table 1), only one individual was observed, and this plant was most likely the survivor of an orchard at an abandoned home. The plant did not show evidence of clonal or sexual reproduction. At the Mill Creek Canyon site (D. Burge 2210; Table 1), few plants were found, and there was evidence that the site was once the location of a homestead or other type of settlement, suggesting that the trees might have been planted. In addition, this site was apparently affected by a recent fire, which killed many of the mature trees, as evidenced by the presence of downed, partially burned trunks. No evidence of seedling recruitment was noted, though viable seeds were recovered from mature fruits on one tree (Table 1). At the second site in San Diego county (D. Burge 2215; Table 1), in the city of Alpine, the population consisted of 10 mature individuals growing in a roadside ditch, several producing viable seeds. However, no seedlings or saplings were observed at this highly modified site, which appears to be actively managed via mowing and vegetation removal. Similar to the San Diego County site at Alpine, the second San Bernardino County site (D. Burge 2211; Table 1) consisted of a few individuals, though of a more diverse age class than at the Alpine site, suggesting some form of reproduction. At the remaining sites in Butte County (D. Burge 2184; Fig. 1) and Tulare County (D. Burge 2202; Fig. 1), relatively extensive populations of variable sized trees were found, with very little evidence of human influence. Nearly all of the most mature trees in these two populations produced fruits with viable seeds (Table 1). At the site in Tulare County, the population formed a virtual monoculture, *D. virginiana* being almost the only plant species, with dozens of saplings per square meter (Burge personal observation).

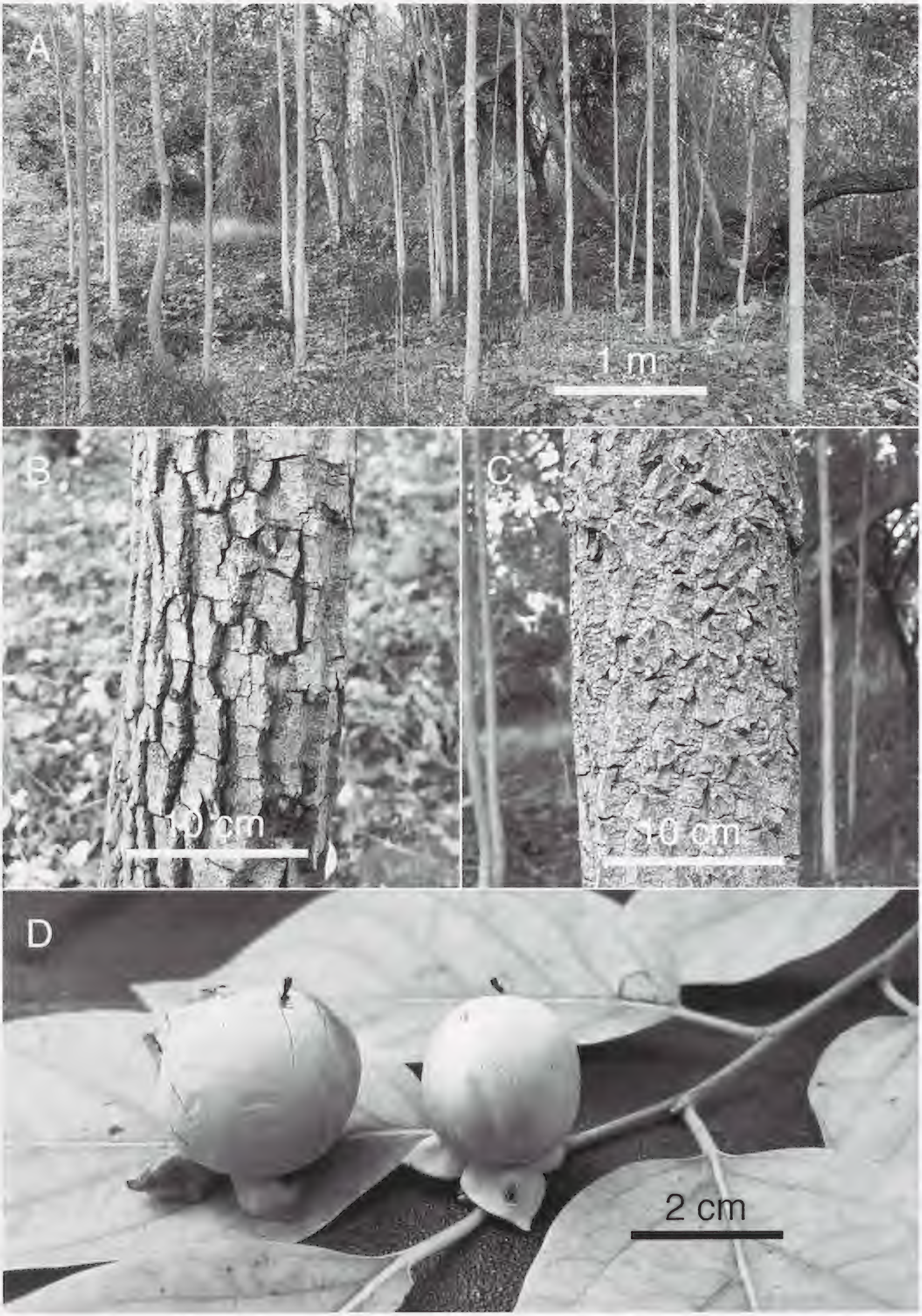

FIG. 1. Representative populations of *D. virginiana* observed in 2016. A–C, South Fork Kaweah River, Tulare County, CA (D. Burge 2202); D, Centerville, Butte County, CA (D. Burge 2184).

DISCUSSION

Diospyros virginiana does not grow indigenously west of Texas, and was therefore most likely introduced to California by humans, probably for use as food (Hrusa et al. 2002). Non-indigenous people of generally European ancestry began to arrive in California in large numbers in the mid-nineteenth century, bringing with them many hundreds of non-native organisms. The descendants of these introductions have become the naturalized flora of California, which is still actively growing, both in terms of diversity and occupied space (Baldwin et al. 2012). *Diospyros virginiana* found outside of cultivation in California is probably descended from plants brought by settlers, possibly even cultivars that are still occasionally grown in the eastern United States (Briand 2005). This idea is to some extent corroborated by the association of *D. virginiana* populations in California with known settlements dating back to the mid-nineteenth century. For example, the Centerville population in Butte County (D. Burge 2184; Fig. 1) occurs at the same location as the now defunct Gold Rush era village of Centerville (Colman 1972). The Kaweah River population in Tulare County (D. Burge 2202; Fig. 1) is also associated with mid to late nineteenth century settlements (Britten 2013; McKee 2013). In fact, recent historical research carried out in the Three Rivers area (McKee 2013; McKee et al. 2017) has revealed that one early settler on the South Fork of the Kaweah River, Ira J. Blossom (1832–1924) was known to plant a variety of fruit trees, which were obtained from USDA Plant Introduction Stations. However, the exact trees species he planted and the stations where these trees originated are not known.

The work presented here provides support for the idea, first proposed by Hrusa et al. (2002), that *D. virginiana* is a naturalized component of the California flora. The wide-ranging size distribution observed in the Butte and Tulare County populations (Table 1), as well as the presence of many apparent seedlings and saplings in both locations, suggests that the populations are self-sustaining. Furthermore, production of viable seeds by trees at all but one of the visited populations suggests that sexual reproduction is taking place. Wild *D. virginiana*, like all other members of the genus *Diospyros*, is dioecious, and females are not known to form seeds unless pollinated. It is therefore evident either that 1) both male and female trees are present in these populations, or 2) that these populations are descended from a perfect-flowered form, examples of which have been developed by tree breeders (Briand 2005). It would be desirable to visit the plant populations in the spring to determine the sex of the trees, and thereby verify if these plants are perfect flowered, as such a condition, if stable, would make these plants much more likely to spread than if they are dioecious (especially if they were capable of self-pollination). In the latter case, both male and female plants would need to become established in a new location for the population to have a chance of sexual reproduction.

Diospyros virginiana does not have many stations outside its native range, and has never been documented as weedy or invasive (*sensu* Richardson et al. 2000). However, its native range it is an early successional invader of abandoned pastures and other disturbed areas (Briand 2005), and has a deserved reputation as a nuisance species due to its propensity to resprout from the crown or roots, making it difficult to eradicate from areas where it is not desired (Briand 2005). Although this species does not appear to be invasive in the ecological context where it was observed in the course of this study, census data suggests that the Butte County and Tulare County populations are self-sustaining and likely spreading. Known animal dispersers of this species are present in California (Briand 2005; Boone et al. 2015), and could facilitate the spread of this plant. Given the association of this species with water courses, additional populations will probably be discovered in riparian areas along the banks of rivers and streams, probably in the vicinity of current or former human habitation. In addition to elucidating the mating system of the naturalized populations, future research should establish where else this plant has become naturalized and determine what effect its presence has on the natural ecosystem in the locations where it is presently found.

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LITERATURE CITED

BOONE, M. J., C. N. DAVIS, L. KLASEK, J. F. DEL SOL, K. ROEHM, AND M. D. MORAN. 2015. A test of potential Pleistocene mammal seed dispersal in anachronistic fruit using extant ecological and physiological analogs. Southwestern Naturalist 14:22–32.

BRIAND, C. H. 2005. The common persimmon (*Diospyros virginiana* L.): the history of an underutilized fruit tree (16th–19th centuries). Huntia 12:71–89.

BRITTEN, S. 2013. Pioneers in paradise: a historical and biographical record of early days in Three Rivers, California, 1850s to 1950s. Dog Ear Publishing, Indianapolis, IN.

COLMAN, L. 1972. Tailings of Butte Creek Canyon 1833–1971: a history of Big Butte and Little Butte Canyons. Cal-Central Press, Sacramento, CA.

CONSORTIUM OF CALIFORNIA HERBARIA. 2017. Data provided by the participants of the Consortium of California Herbaria. Website http://ucjeps.berkeley.edu/consortium [accessed 30 June 2017].

ECKENWALDER, J. E. 2009. Ebenaceae. Pp. 247–249 *in* Flora of North America editorial committee, Flora of

North America north of Mexico, Volume 8. Oxford University Press, New York, NY.

HRUSA, F., B. ERTTER, A. SANDERS, G. LEPPIG, AND E. DEAN. 2002. Catalogue of non-native vascular plants occurring spontaneously in California beyond those addressed in The Jepson Manual—Part I. Madroño 49:61–98.

JEPSON FLORA PROJECT (EDS.). 2017. Jepson eFlora. Website http://ucjeps.berkeley.edu/IJM [accessed 30 July 2017].

KARTESZ, J. T. 2017. The Biota of North America Program (BONAP). North American Plant Atlas. Website http://bonap.net/napa [accessed 30 July 2017].

MCKEE, E. A., JR. 2013. Echoes of Blossom Peak: cowboys, horsemen, and history of Three Rivers. CreateSpace Independent Publishing Platform.

———, G. B. MCKEE, AND C. N. MCGREW. 2017. Echoes of Three Rivers: landmarks and lore. CreateSpace Independent Publishing Platform.

OSWALD, V. H. AND L. AHART. 1998. Manual of vascular plants of Butte County. California Native Plant Society. Sacramento, CA.

RICHARDSON, D. M., P. PYŠEK, M. REJMÁNEK, M. G. BARBOUR, F. D. PANETTA, AND C. J. WEST. 2000. Naturalization and invasion of alien plants: concepts and definitions. Diversity and Distributions 6:93–107.

APPENDIX

SAMPLED *DIOSPYROS* POPULATIONS

For each sampled population (Table 1), the format is as follows: collector name and number (herbarium of voucher specimen deposition), description of locality, county, GPS coordinates, County, State.

DIOSPYROS VIRGINIANA—D. O. Burge 2184 (DAV), 22 Oct 2016, Centerville area, Butte Creek watershed (GPS [NAD84]: 39.79658, –121.6485), Butte Co., CA. D. O. Burge 2202 (DAV), 20 Nov 2016, South Fork Kaweah River, roadside on South Fork Drive (GPS [NAD84]: 36.40577, –118.88623), Tulare Co., CA. D. O. Burge 2210 (DAV), 10 Dec 2016, Mill Creek Canyon, near Mountain Home Village (GPS [NAD84]: 34.09738, –116.97832), San Bernardino Co., CA. D. O. Burge 2211 (DAV), 10 Dec 2016, San Bernardino Mountains, Old Mormon Road Monument (GPS [NAD84]: 34.23316, –117.29418), San Bernardino Co., CA. D. O. Burge 2215 (DAV), 17 Dec 2016, Alpine, roadside on Alpine Boulevard (GPS [NAD84]: 32.83438, –116.75354), San Diego Co., CA. D. O. Burge 2217 (DAV), 17 Dec 2016, Lawson Creek, S of confluence with Sweetwater Creek (GPS [NAD84]: 32.76468, –116.79545), San Diego Co., CA.